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(71) Applicant
Rovex Limited
Westwood Industrial Estate, Margate, Kent CT9 4JX.
(72) Inventor
Greville George Bloodworth
(74) Agents
Messrs. J. A. Kemp & Co.

(54) **Remote control systems and transmitters and receivers therefor**

(57) A remote control system for controlling electrical devices *via* their power supply lines comprises a transmitter for sending control signals in time division multiplexed fashion to a number of receivers, each of which can identify the associated time slot in the multiplexing scheme. Each time slot corresponds to an integral number of half cycles of the supply waveform and both binary and proportional control information may be conveyed by the position of the control signals within their time slots.

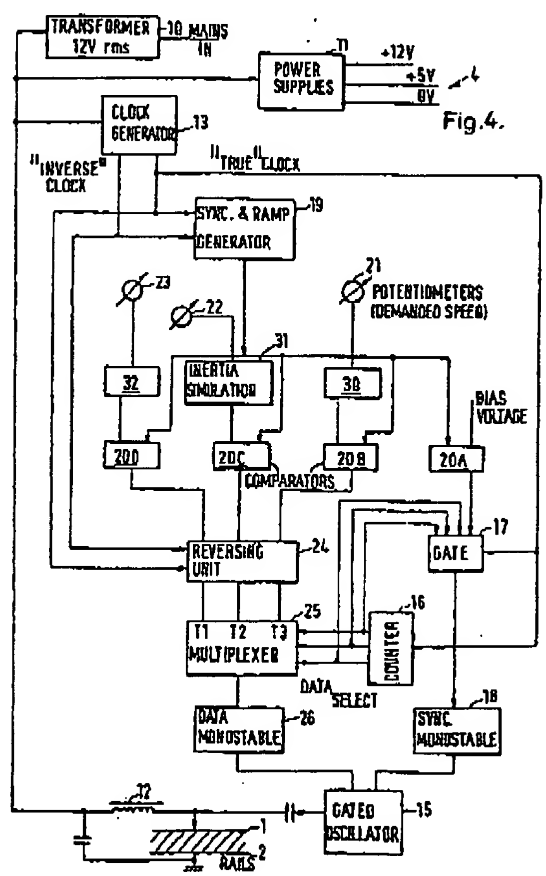

Fig.4.

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Fig.1.

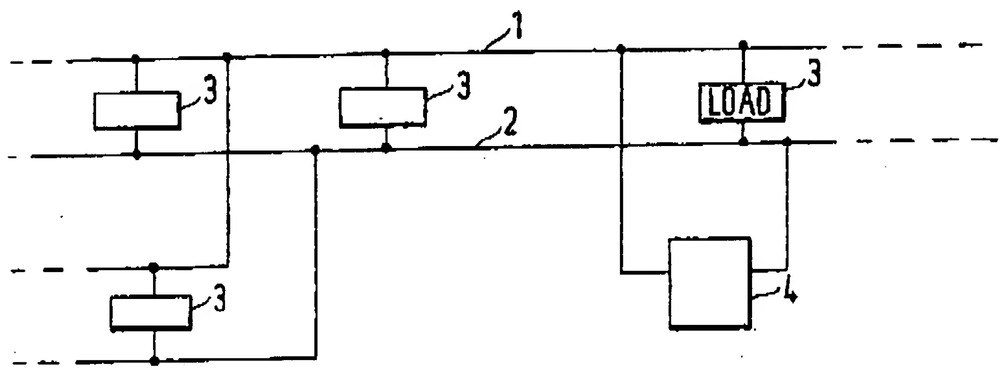

1
2
3
3
3
3
LOAD
4

Fig.2.

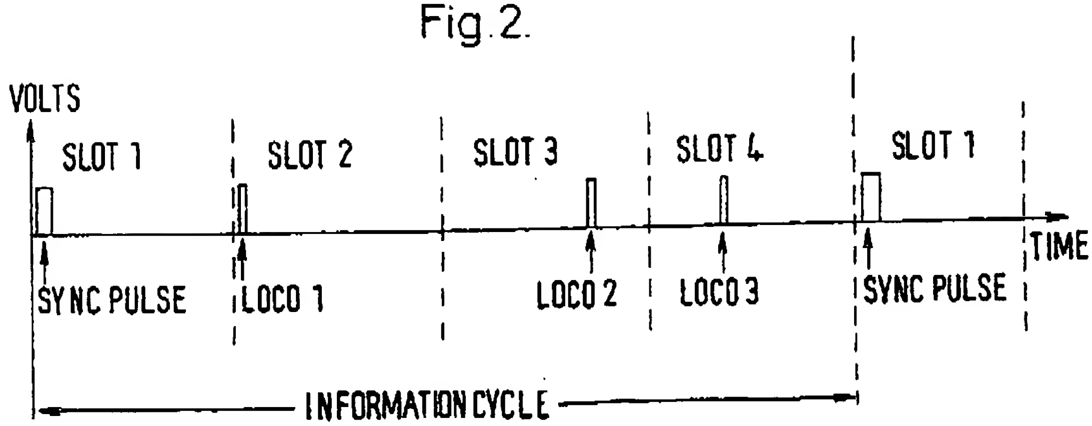
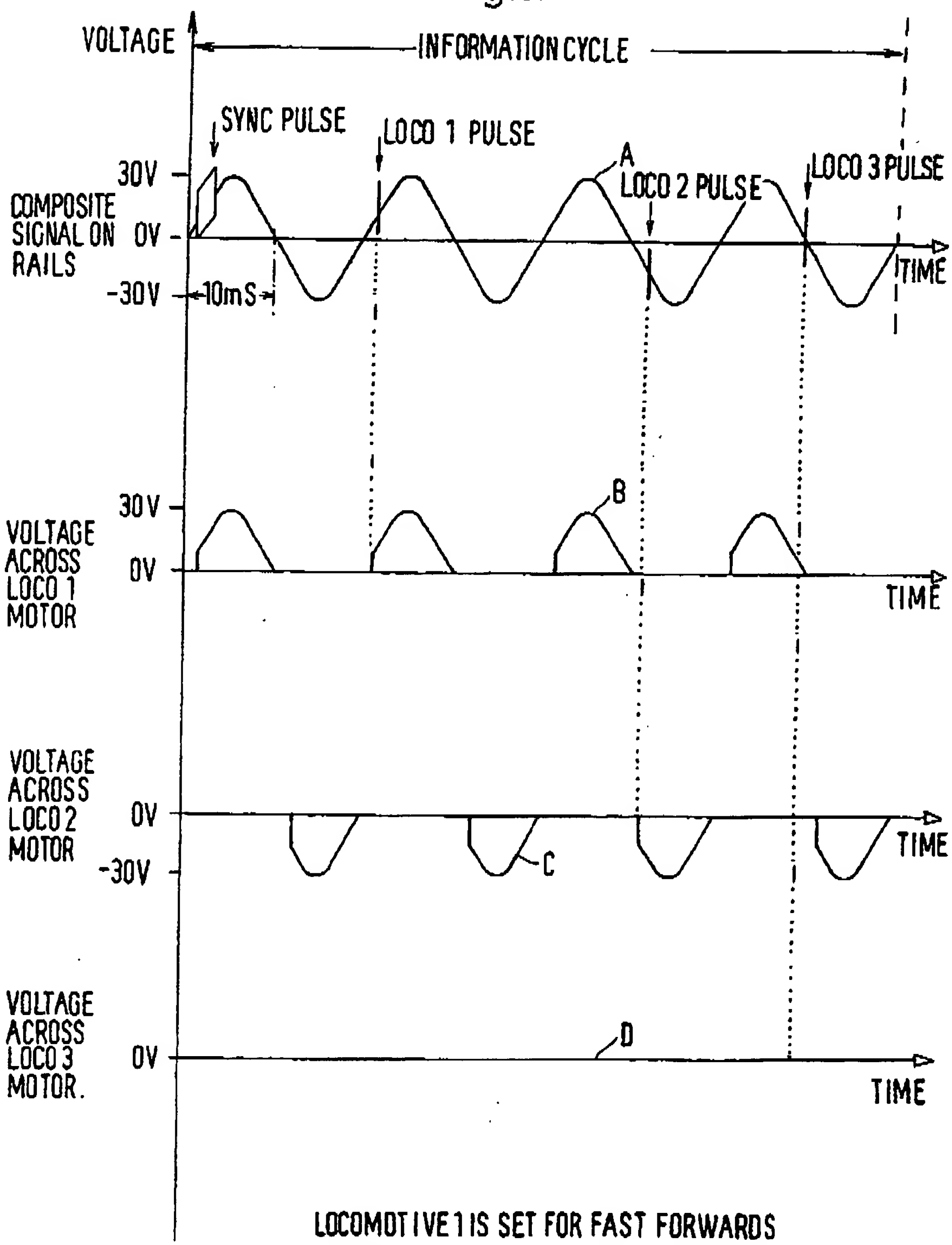

VOLTS
SLOT 1
SLOT 2
SLOT 3
SLOT 4
SLOT 1
TIME
SYNC PULSE
LOCO 1
LOCO 2
LOCO 3
SYNC PULSE
INFORMATION CYCLE

Fig.3.



LOCOMOTIVE 1 IS SET FOR FAST FORWARDS
LOCOMOTIVE 2 IS SET FOR FAST BACKWARDS
LOCOMOTIVE 3 IS SET FOR STOPPED (FORWARDS)

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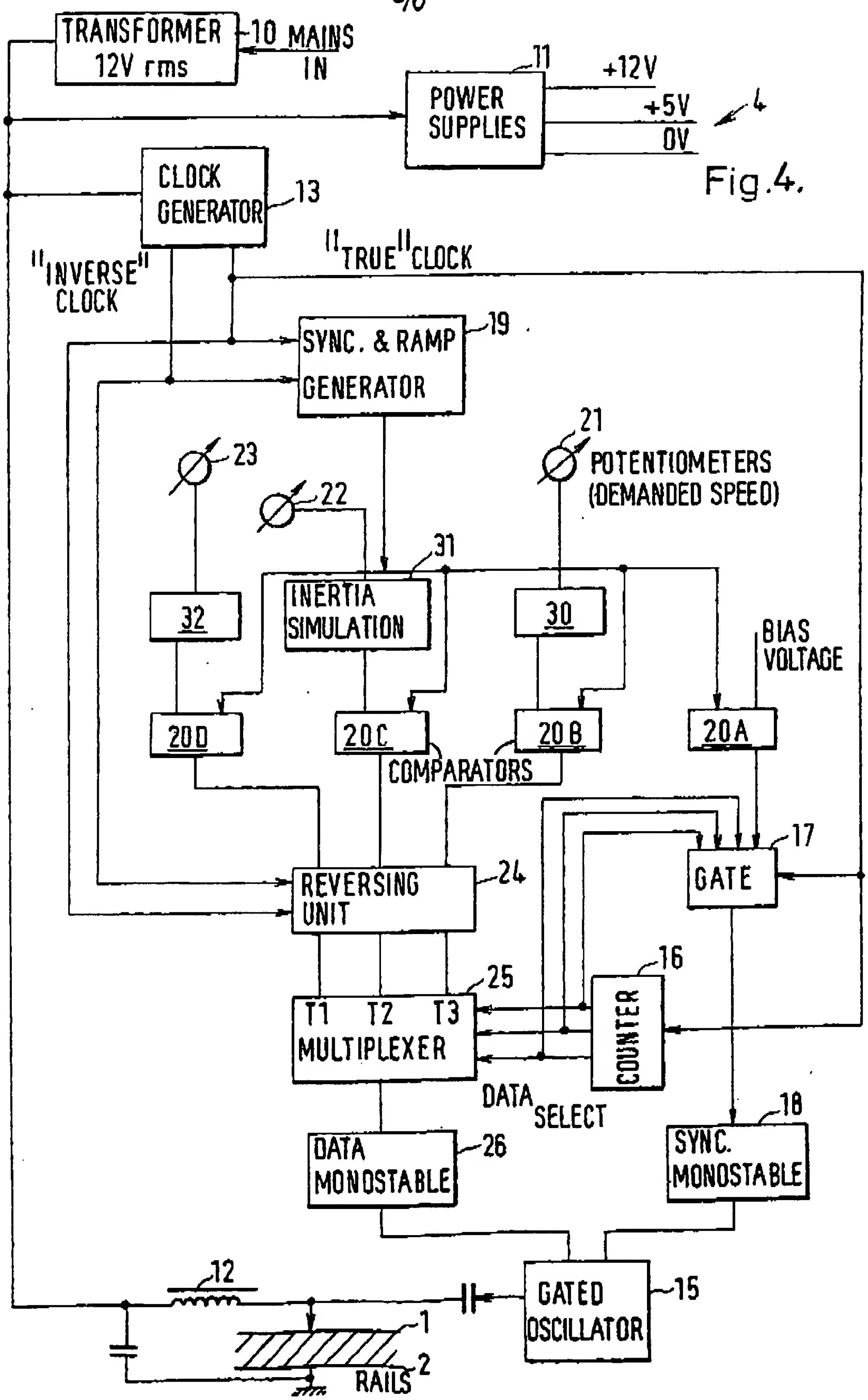


Fig.4.

Fig.5.

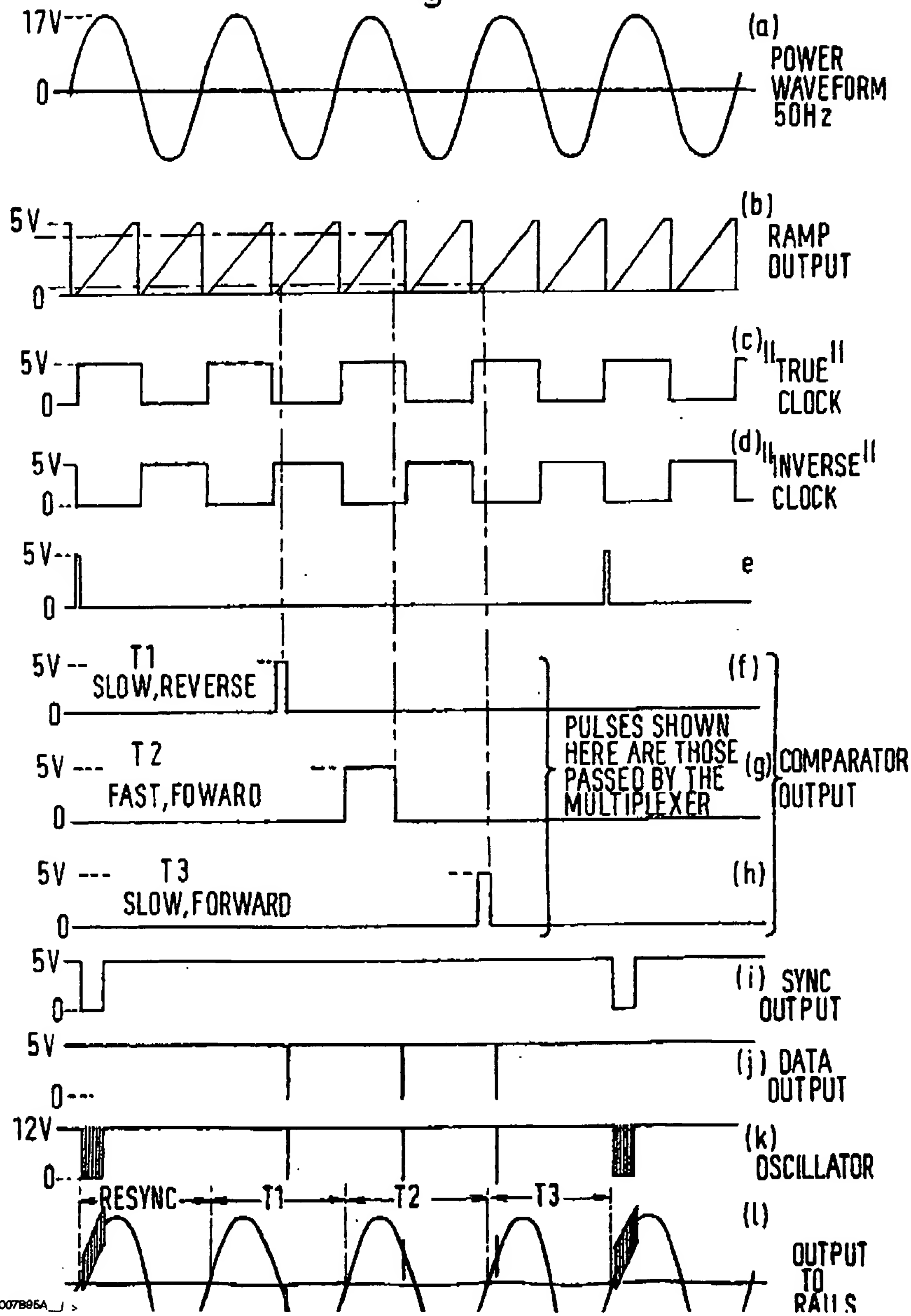
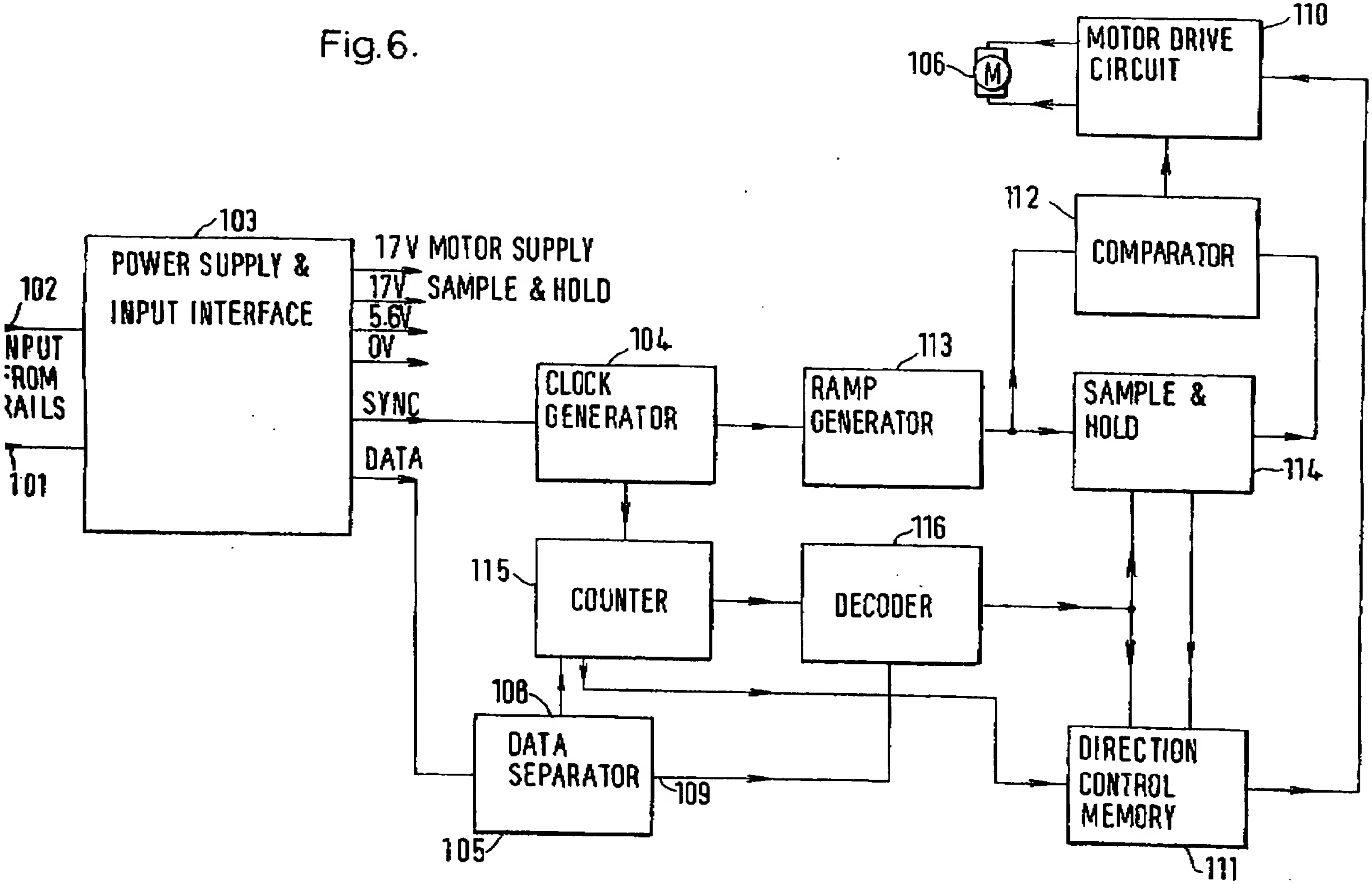

17V
0
(a) POWER WAVEFORM 50Hz
5V
0
(b) RAMP OUTPUT
5V
0
(c) "TRUE" CLOCK
5V
0
(d) "INVERSE" CLOCK
5V
0
e
5V
T1
SLOW,REVERSE
0
(f)
5V
T2
FAST,FOWARD
0
PULSES SHOWN HERE ARE THOSE PASSED BY THE MULTIPLEXER
(g) COMPARATOR OUTPUT
5V
T3
SLOW,FORWARD
0
(h)
5V
0
(i) SYNC OUTPUT
5V
0
(j) DATA OUTPUT
12V
0
(k) OSCILLATOR
RESYNC
T1
T2
T3
(l) OUTPUT TO RAILS

Fig. 6.


POWER SUPPLY & INPUT INTERFACE
103
102
INPUT FROM RAILS
101
17V MOTOR SUPPLY
17V
SAMPLE & HOLD
5.6V
0V
SYNC
DATA
CLOCK GENERATOR
104
RAMP GENERATOR
113
COMPARATOR
112
MOTOR DRIVE CIRCUIT
110
106
M
SAMPLE & HOLD
114
COUNTER
115
DECODER
116
DATA SEPARATOR
108
105
109
DIRECTION CONTROL MEMORY
111

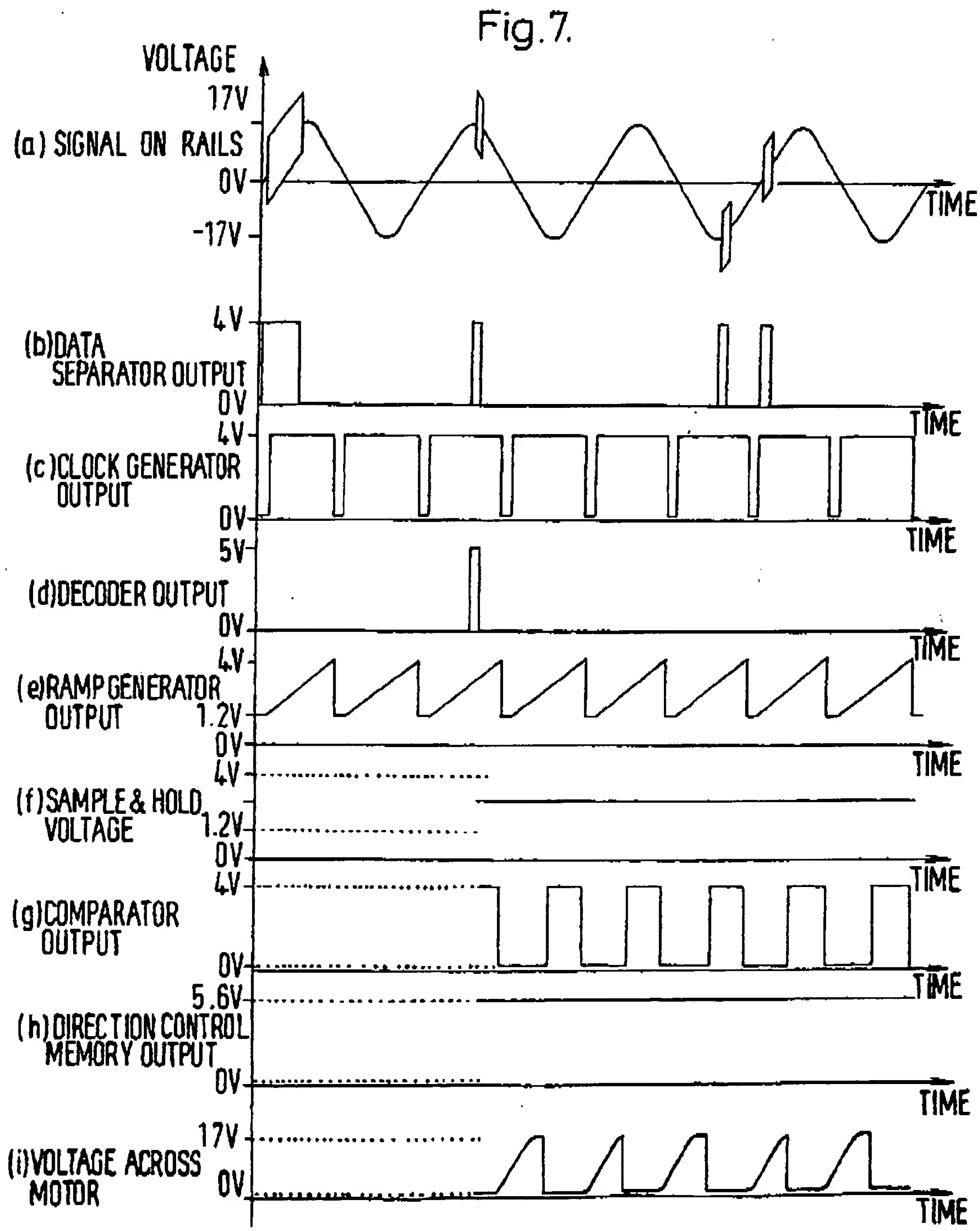


Fig.7.
VOLTAGE
17V
(a) SIGNAL ON RAILS
0V
-17V
TIME
4V
(b)DATA SEPARATOR OUTPUT
0V
TIME
4V
(c)CLOCK GENERATOR OUTPUT
0V
TIME
5V
(d)DECODER OUTPUT
0V
TIME
4V
(e)RAMP GENERATOR OUTPUT
1.2V
0V
TIME
4V
(f)SAMPLE & HOLD VOLTAGE
1.2V
0V
TIME
4V
(g)COMPARATOR OUTPUT
0V
TIME
5.6V
(h)DIRECTION CONTROL MEMORY OUTPUT
0V
TIME
17V
(i)VOLTAGE ACROSS MOTOR
0V
TIME

SPECIFICATION

Remote control systems and transmitters and receivers therefor

The present invention relates to a remote control system for controlling the operation of at least one electrical device *via* power supply lines to the device(s), and to a receiver and transmitter for use in such a system.

It is frequently desired to control the operation of an electrical device from a remote location without the need for the provision of separate control signal conductors, radio control devices and the like.

According to the present invention we provide a remote control system for remotely controlling at least one electrical device by means of control signals transmitted, in use, *via* a power supply line to the device or devices, the system comprising a transmitter for connection to the power supply lines to transmit the control signals and at least one receiver for connection to the power supply lines to receive the control signals, the transmitter (a) including a time division multiplexer defining a plurality of cyclically recurring time slots so as to enable transmission of individual control signals to a plurality of such receivers and (b) being arranged to encode the control signals such that control information is represented by the position of the control signals within the time slots, and the or each receiver being arranged (a) to identify the occurrence of a time slot assigned thereto, and (b) to decode the control signals occurring in that time slot and in response thereto to produce output signals for controlling an electrical device associated therewith.

The control signals can be conveniently be high frequency bursts or pulses superimposed on the supply, for example by a gated oscillator, the control signals occupying a frequency band widely separated from the supply, if the latter is AC.

In order to facilitate the identification by a receiver of the time slot assigned thereto, synchronising signals can also be transmitted *via* the power supply electrical conductors, these synchronising signals conveniently being assigned their own time slot in the information cycle (that is, the interval of time in which each time slot occurs once).

Preferably each time slot corresponds to an integral number of half-cycles of the supply where the supply is AC or half-or full-wave rectified AC. It can then be relatively simple for the transmitter and receiver(s) to generate clock pulse signals synchoronised with the supply waveform, e.g. by detecting the zero crossovers of the supply waveform. Where two or more information channels to each receiver are required, the various channels' information may be transmitted during successive half cycles of the supply waveform during the time-slot associated with that receiver.

The control signals can, of course, represent simple on/off information as, for example, turning on or off a light, or proportional information, e.g. speed information where the electrical device is a motor. They can include direction of a motion information where the device to be controlled is a motor. One convenient way of using the system to carry out proportional control of the electrical devices is to use the timing of the control signal within the time slot to represent the magnitude of the demanded parameter, e.g. motor speed, of the electrical device.

In the transmitter, a counter clocked at a suitable rate and synchronised with the supply waveform provides a particularly simple way of defining each time slot. Thus the counter may be used in combination with a multiplexer which allows each of the control signals to trigger a gated oscillator during its individual time slot. Proportional control signals can be derived by comparison of the set value with a ramp signal synchronised with the supply waveform.

The invention also provides a transmitter for use in a remote control system in use of which control signals are delivered to a plurality of receivers associated with respective electrical devices to be controlled *via* power supply lines to the devices, the transmitter comprising: a time division multiplexing arrangement for defining a cyclically recurring sequence of time slots during which control signals can be transmitted for individual receivers; means for generating the control signals in a manner such that the position of a control signal within a time slot is representative of control information; and means for delivering the control signals to an output to be connected to the power supply lines.

The invention further provides a receiver for use in a remote control system in use of which control signals are transmitted in time division multiplex fashion to a plurality of such receivers associated with respective electrical devices to be controlled *via* power supply lines to the devices, individual receivers having a respective time-slot assigned thereto, the receiver comprising: an input for connection to the power supply lines; means for identifying the occurrence of a time slot assigned to the receiver; and means for decoding control signals received at said input during the assigned time slot to produce output signals to control an electrical device associated with the receiver, the decoding means being operative to decode a control signal on the basis of its position within the assigned time slot. Thus in use, the receiver extracts the control signals occurring during its assigned time slot and from these signals derives control information to control the operation of the associated device. Conveniently, the receiver includes a ramp generator for generating a ramp signal synchronised with each time slot, a sample and hold circuit connected to the ramp generator and arranged to sample the value of the ramp signal each time a control signal occurs within the receivers assigned time slot and for retaining the stored value until such a control signal next occurs and a comparator for comparing the ramp signal with the stored value to produce an output signal to control the associated electrical device. This provides a simple way to ensure that the device continues to operate between updates of the control information. By arranging that the time constant of the sample and hold circuit is such as to

prevent the stored value changing by more than a predetermined fraction at each sampling, it is possible to provide the receiver with a certain degree of immunity to electrical noise on the supply lines since the rate of change of the control information is thereby limited.

In the following description, the present invention is described with particular reference to its application to model railways although it will be appreciated that the invention is not in any way limited exclusively to that application and indeed it will be apparent that nearly all the features of the described embodiment can be used in other applications.

The invention will be further described with reference to the accompanying drawings in which:–

Figure 1 is a block schematic diagram to illustrate the overall operation of an embodiment of the invention;

Figure 2 is a timing chart indicating information timing for the arrangement of Figure 1;

Figure 3 shows waveforms occurring in an embodiment of the invention having three model railway locomotives;

Figure 4 is a block schematic diagram of a combined power supply and controller for an embodiment of the present invention;

Figure 5 shows waveforms occurring at various points in the circuit of Figure 4;

Figure 6 is a block schematic diagram of a receiver for use in an embodiment of the present invention;

Figure 7 shows waveforms occurring in various parts of the circuit of Figure 6.

In the system shown in Figure 1, a pair of electrical conductors 1,2, supply power to a plurality of electrical loads 3 connected across the conductors 1, 2. Also connected to the conductors 1, 2, is a combined power supply and controller 4 which energises and controls the various loads 3, which each include an electrical device to be energised and controlled and a receiver for receiving control signals from the controller 4 *via* the conductors 1, 2.

In our preferred embodiment, which pertains to a model railway layout, the loads 3 are individual model railway locomotives which run on and receive power from the conductors 1 and 2 which constitute the railway tracks. The speed and direction of motion of each of the locomotives is controlled from the controller 4.

The operating principle of the embodiment can be appreciated from Figures 2 and 3. The power supply 4 applies an AC voltage across the lines 1 and 2, this voltage being derived *via* a transformer from the electrical mains supply and serving to energise the motors of the locomotives 3. Direction and speed control signals for the locomotives 3 are superimposed on this voltage by the controller 4, the control signals for a number of locomotives 3 being transmitted in time-division multiplex fashion.

Thus, as indicated by Figures 2 and 3, control signals for each of a number of locomotives are transmitted in turn during a periodically repeating information cycle. Each information cycle commences with a synchronising pulse, which serves to synchronise circuitry within the receiver of each locomotive 3, and is divided into a number of time-slots, each locomotive being assigned a respective time-slot during which speed and direction control signals individual to that locomotive are transmitted *via* the lines 1 and 2.

It is convenient if each time-slot, including the time-slot during which the synchronising pulse occurs, corresponds to an integral number of half-cycles of the AC mains supply, commencing at a zero crossover. Thus the receiver circuitry can readily identify the start of each time slot by detecting the predetermined part of the waveform, e.g. the zero crossovers (or zero approaches in the case of full or half wave rectified AC) of the supply waveform and the individual time slots can be identified by counting the zero crossovers occurring after the synchronising pulse. Suitably, to enable information such as forward/reverse commands to be readily dealt with, each time slot corresponds to a whole cycle of the supply waveform.

Within each time slot, a control pulse is transmitted for the associated locomotive, and the position of the control pulse within the time-slot provides the locomotive 3 with information both as to its commanded direction of motion and its speed. Thus, within each time slot, the polarity of the half cycle of the supply cycle during which the control pulse occurs indicates the commanded direction of motion, while the time delay between the immediately preceding zero-crossover of the supply waveform and the control pulse represents a phase angle for controlling the supply to the locomotive motor. The time slot for each locomotive could, of course, comprise more than two half cycles of the supply waveform so that other signals for controlling a whistle or coupling, for example, could also be transmitted, these signals being identified as such by the position within the time slot of the half cycle(s) during which they occur.

Figure 3 shows typical waveforms occurring in a system comprising three model railway locomotives. In Figure 3, waveform A is the waveform of the composite signal, which comprises the locomotive motor supply and the control signals, applied across the tracks of the railway. It will be seen that each information cycle is divided into four time slots, during the first of which the synchronising pulse is transmitted and during the later three of which, control signals individual to each of the three locomotives are transmitted. Each time slot corresponds to one complete period of the mains waveform. During the first time slot, the synchronising pulse is superimposed on the supply waveform, the synchronising pulse being in the form of a burst of oscillation of high frequency, for example, 1MHz.

The control signals for the locomotives which are also superimposed on the supply waveform may be similarly constituted but of a duration which is different from that of the synchronising pulse to enable circuitry within the locomotives to distinguish between the synchronising pulse and the indi-

vidual locomotive control pulses. Each of the locomotives detect the synchronising pulse and a counter in the locomotive then starts to count the number of zero crossovers of the supply waveform occurring subsequent to the synchronising pulse, to identify the time slot associated with that locomotive. During the time slot associated with a particular locomotive, the control pulse assigned to that locomotive is detected and speed and direction of motion control signals are derived from it. The values of these signals are then stored until the arrival of the control pulse assigned to that locomotive during the next information cycle.

The waveforms B, C and D represent the voltages applied across the motors of locomotives responding to control pulses occurring during the second, third and fourth time slots respectively of the waveform. Waveform B indicates that the motor of the associated locomotive is turned on early during each cycle of the mains waveform and the occurrence of the associated control pulse during a positive half-cycle of the supply waveform means that the voltage across the motor is to be of the polarity appropriate to cause forward motion of the locomotive. The net effect, therefore, is that the locomotive is set for fast forward action. Similarly, the locomotive corresponding to waveform C is set for fast backwards motion while the locomotive associated with waveform D is stopped.

Figure 4 shows in block form the main functional elements of the combined power supply and controller of Figure 1. Connected to the AC electrical mains supply is a transformer 10 with a nominal output of 12 volts RMS which energises a power supply 11 and the rails 1 and 2 *via* an inductor 12. The power supply 11 serves in turn to energise the remainder of the control circuit. Also receiving the output of transformer 10 is a clock generator 13 which derives circuitry generally designated 14, the purpose of the circuitry 14 being to control the operation of a gated oscillator arranged to operate at 1MHz to provide the synchronising and locomotive control pulses which are superimposed on the AC supply waveform applied across the rails 1 and 2.

The clock generator serves to synchronise the operation of the circuitry 14. The clock generator 13 detects the zero-crossovers of the output of transformer 10 and provides two square wave outputs (c) and (d) in Figure 5, these square waves being the inverse of one another. The square wave (c) is applied to the count input of a counter 16 which serves to define the time slots during which the synchronising pulses and the locomotive control pulses are transmitted. A multiple input gate 17 detects when the count in the counter corresponds to the time slot during which the synchronising pulse is to be transmitted and, during that time slot, triggers a monostable circuit 18 which gates the oscillator 15 on to produce the synchronising pulse.

The clock generator 13 also drives a ramp generator 19 which provides a ramp output with a frequency equal to twice that of the output of transformer 10. This output is applied to a respective input of each of four comparators 20 A–D. The comparator 20 A compares the ramp voltage with a fixed bias voltage applied to second input thereof so that the gate 17 triggers the monostable 18 when the ramp voltage exceeds the bias voltage.

The three other comparators, 20 B–D are used to produce control pulses assigned to three locomotives, the commanded speed of each of which can be set by use of respective potentiometers 21,22,23. These potentiometers provide respective demanded-speed representing voltages which are applied to one input of the respective comparator 20 B, 20 C, 20D, by which they are compared with the 100 Hz output from ramp generator 19. Thus each comparator 20 B– D will produce an output once every 100th of a second, that is to say twice during each cycle of the output of transformer 10. A reversing unit 20 is used to select one of the two pulses per supply cycle from the comparators 20 B–D to be applied to the input of a multiplexer 25. Which of the two pulses from each comparator 20 B–D is selected is determined by a control (not shown) associated with each locomotive which is used to set the commanded direction of motion of that locomotive. Thus, for example, in the case of the locomotive associated with comparator 20 B, if it is desired that that locomotive proceeds in the forward direction, the reversing unit 24 is programmed to transmit pulses from the output of comparator 20 B which occur during the positive half-cycles of the output of transformer 10 while if the locomotive is to proceed backwards, the reversing unit will select the pulses occurring during the negative half-cycles of the output of transformer 10.

The multiplexer 25 selects data applied to three inputs T1–3 by the reversing unit 24 in accordance with the output states of counter 16. Each different count of counter 16 corresponds to a respective time slot of the information cycle and thus the pulses transmitted *via* the reversing unit 24 from the comparators 20 B–D are transmitted through the multiplexer during the appropriate time slots and then trigger a data monostable 26 which gates on the oscillator 15 to produce the control pulses for each locomotive. The composite waveform applied across the rails 1 and 2 is indicated at (1) in Figure 5.

In order to provide a realistic response of the locomotives to sudden changes in demanded speed, respective inertia simulation circuits 30, 31 and 32 are connected between each potentiometer 21 and 22 and 23 and the associated comparator. These inertia simulation circuits add a long time-constant to changes in the demanded locomotive speed. It will be apparent that this effect can also be achieved in a similar fashion at the receiver.

Figure 6 shows in block diagram form a receiver which may be incorporated in one of the locomotives to respond to signals from the controller of Figure 4, while Figure 7 shows waveforms occurring in various parts of the circuit of figure 6. Two conductors 101 and 102 are electrically connected to one or more wheels of the locomotive to establish an electrical connection with the rails 1,2 and are also connected to a power supply and interface

circuit 103 which uses a full-wave rectifier bridge to rectify the supply waveform to provide supplies to energise the drive motor 106 of the locomotive and the control circuitry within the locomotive. The output of the rectifier bridge is also applied to the input of a clock generator circuit 104 which produces an asymmetrical output as indicated at (c) in Figure 7.

Also connected to the power supply and input interface circuit 103 is a data separator circuit 105 which filters the synchronising pulses and control pulses from the input across the conductors 101 and 102 and delivers the synchronising pulses for an output 108 and the control pulses from an output 109.

The drive motor 106 is supplied with current by a motor drive circuit 110 which comprises a transistor bridge so that the polarity of the output to the motor 106 can be selected as desired to provide forward or reverse running of the locomotive. The direction of current flow through the motor 106 is set by means of a direction control memory 111 which is in the form of a bistable flip-flop whose output is connected to the motor drive circuit 110 and whose operation will be described in greater detail below.

The motor drive circuit 110 is arranged so that current will be supplied to the motor 106 during each of the half-cycles of appropriate polarity of the supply waveform across the rails (depending on the set direction of motion) until a pulse is applied to the motor drive circuit by a comparator 122. The timing of the output pulse from comparator 112 thus provides means for providing variable phase control of the operation of motor 106. The comparator 112 produces an output pulse when the output voltage of a ramp generator 113 exceeds the output voltage from a sample and hold circuit 114 which stores a signal representative of the set locomotive speed. Ramp generator 113 produces a 100Hz ramp waveform as indicated at (a) in Figure 7, being triggered by clock generator 104.

As mentioned above, the sample and hold circuit stores, e.g. across a capacitor, a voltage representative of the set speed of the locomotive, as commanded by control pulses assigned to the locomotive and superimposed on the supply waveform across the rails. How this is achieved will now be explained.

The data separator circuit 105 delivers from an output 108 the stream of synchronising pulses and on the occurrence of each synchronising pulse a counter 115 is re-set to zero. This counter 115 counts clock pulses from the clock generator 104. As the counter 115 is clocked at 100Hz, it holds each count for the period of a respective time slot of the information cycle. A decoder 116 receives the true and inverse outputs of the counter 115 and serves to identify the particular time slot associated with the locomotive by detecting when the counter output corresponds to the associated time slot. During the time slot associated with the locomotive, the decoder 116 will allow control pulses delivered from the output 109 of data separator 105 to be applied to the trigger input of sample and hold circuit 114 causing it to undergo a fresh sample and hold operation. The control pulses which reach sample and hold circuit 114 are thus those originally assigned to that locomotive by the controller 4 described above. When the sample and hold circuit 114 receives the trigger pulse from decoder 116, the sample and hold circuit samples, and thereafter holds, the voltage reached by the ramp generator 114 at that instant of time. The ramp voltage increases linearly with respect to time, this voltage is thus representative of the time delay between the arrival of the pulse from decoder 116 and the immediately preceding zero crossover of the supply waveform. This voltage is then held and subsequently compared by comparator 112 with the output of ramp generator 114 to carry out phase control of the supply current to motor 116, in accordance with the setting of the associated potentiometers in the controller 4.

It will be appreciated that discontinuities may occur in electrical contact between the wheels of the locomotive and the tracks and unless precautions were taken, this could lead to spurious operation of the motor 116. To prevent this, the time constant of sample and hold circuit 114 is chosen in relation to its sampling time so that the stored voltage can only change by a maximum of 20% during each sampling period.

The direction control memory 111 controls the direction of motion of the locomotive in accordance with whether the associated control pulse received from the tracks occur during the positive or negative half-cycle of the supply waveform. The data input to the bistable within direction control memory 111 is a 50 Hz signal derived from the first stage of counter 115. The bistable is clocked by the control pulse outputed from decoder 116. The bistable output state is therefore set (or remains) high or low according to the polarity of the supply half-cycle in which the control pulse is present. In order to avoid spurious operation of the bistable, the clock is inhibited by the sample and hold circuit 114 is non-zero phase information is already stored, that is when the locomotive is already in motion. Thus motion reversal can only occur after the locomotive has first been brought to rest.

The following are the values of parameters used in a prototype of the illustrated embodiment:

System power supply	12 volts rms, 50Hz
Control pulse width	≈ 0.27 mS
Synchronising pulse width	≈ 3.3mS
Pulse amplitude	10 volts
Gated oscillator frequency	1 MHz
Information cycle length	4 cycles
Number of active control channels	3

The length of the control and synchronising pulses and the associated time constant in the locomotive receiver were chosen as a compromise between high phase-resolution and immunity to transient interference.

It will be appreciated that there are a variety of other applications of the present system in the context of model railways. Thus, for example, it could be used for the controller signalling, points and other peripheral equipment.

In certain applications, e.g. model railways, it

may be advantageous for the supply waveform to be a high frequency rectangular waveform. This would allow simplification of the receiver circuitry, for example by the elimination of the need for signal squaring circuitry within the receiver circuitry.

CLAIMS

1. A remote control system for remotely controlling at least one electrical device by means of control signals transmitted, in use, *via* a power supply line to the device or devices, the system comprising a transmitter for connection to the power supply lines to transmit the control signals and at least one receiver for connection to the power supply lines to receive the control signals, the transmitter (a) including a time division multiplexer defining a plurality of cyclically recurring time slots so as to enable transmission of individual control signals to a plurality of such receivers and (b) being arranged to encode the control signals such that control information is represented by the position of the control signals within the time slot, and the or each receiver being arranged (a) to identify the occurrence of a time slot assigned thereto, and (b) to decode the control signals occurring in that time slot and in response thereto to produce output signals for controlling an electrical device associated therewith.

2. A remote control system according to claim 1, adapted for use with a periodic power supply waveform, the arrangement being such that the time slots are synchronised with the periods of the supply waveforms.

3. A remote control system according to claim 2, wherein the supply waveform is AC or full- or half-wave rectified AC and each time slot corresponds to one or more integral half cycles of the waveform.

4. A remote control system according to claim 3 wherein proportional control information is represented by the time of occurrence of each control signal relative to a previous, predetermined part of a cycle of the supply waveform.

5. A remote control system according to claim 4 wherein said predetermined part is a zero-crossover or zero-approach of the supply waveform.

6. A remote control system according to claim 3, 4 or 5 wherein binary-type control information is represented by which, of a plurality of half cycles making up a time slot, the control signal occurs in.

7. A remote control system according to any one of claims 3 to 6 wherein the transmitter is arranged to transmit a synchronising signal during each group of time slots and the receivers are adapted to detect the synchronising signal and use it to identify the respective time slots assigned thereto.

8. A transmitter for use in a remote control system in use of which control signals are delivered to a plurality of receivers associated with respective electrical devices to be controlled *via* power supply lines to the devices, the transmitter comprising: a time division multiplexing arrangement for defining a cyclically recurring sequence of time slots during which control signals can be transmitted for individual receivers; means for generating the control signals in a manner such that the position of a control signal within a time slot is representative of control information; and means for delivering the control signals to an output to be connected to the power supply lines.

9. A transmitter according to claim 8 wherein the time division multiplexing means is arranged to synchronise the time slots with the supply waveform.

10. A transmitter according to claim 8 or 9 for use with an AC or full-wave- or half-wave-rectified AC supply waveform wherein the arrangement is such that each time slot corresponds to an integral number of half cycles.

11. A transmitter according to claim 8, 9 or 10 and arranged to produce control signals whose positions within the time slots represent proportional control information.

12. A transmitter according to claim 11 wherein one or more comparators are provided to compare input signals with a progressively changing reference signal and the control signal generating means is arranged to generate a control signal when the comparator(s) detects a predetermined relationship between the control information and the reference signal.

13. A transmitter according to any one of claims 8 to 12 and including means for periodically generating a synchronising signal to be applied to said output to identify the start of a sequence of time slots.

14. A transmitter according to claim 13 wherein the synchronising signal generating means is arranged to produce the synchronising signal at a zero-crossover or zero-approach of the supply waveform.

15. A receiver for use in a remote control system in use of which control signals are transmitted in time division multiplex fashion to a plurality of such receivers associated with respective electrical devices to be controlled *via* power supply lines to the devices, individual receivers having a respective time slot assigned thereto, the receiver comprising: an input for connection to the power supply lines; means for identifying the occurrent of a time slot assigned to the receiver; and means for decoding control signals received at said input during the assigned time slot to produce output signals to control an electrical device associated with the receiver, the decoding means being operative to decode a control signal on the basis of its position within the assigned time slot.

16. A receiver according to claim 15 for use with a composite waveform on said supply lines, the composite waveform comprising a regularly varying power supply waveform and said control signals superimposed thereon, wherein the time slot identifying means is operative to identify the assigned time slot by detecting the occurrence of a predetermined part of said composite waveform.

17. A receiver according to claim 16 wherein said identifying means comprises a circuit arranged to detect a synchronising signal periodically superimposed on the supply waveform and to

count a number of zero-cross-overs or zero-approaches of the composite waveform subsequent to each occurrence of the synchronising signal to identify the assigned time slot.

18. A receiver according to claim 16 or 17 and comprising means for storing the control information between occurrences with the control signal assigned to the receiver.

19. A receiver according to any one of claims 15 to 19 and comprising a ramp generator for generating a ramp signal synchronised with each time slot, a sample and hold circuit connected to the ramp generator and arranged to sample the value of the ramp signal each time a control signal occurs within the receiver's assigned time slot and for retaining the stored value until such a control signal next occurs and a comparator for comparing the ramp signal with the stored value to produce an output signal to control the associated electrical device.

20. A receiver according to claim 19 wherein the time constant of the sample and hold circuit is such as to prevent the stored value changing by more than a predetermined fraction at each sampling.

21. A receiver according to any one of claims 15 to 20 for use in controlling an electric motor in a system in which the time slot assigned to the receiver comprises two half cycles of the supply waveform, the decoding circuit being operative to decode motor direction control information on the basis of in which of the two half cycles a control signal occurs and to decode motor speed control information from the position of the control signal within the period of that half cycle.

22. A remote control system according to any one of claims 1 to 7, a transmitter according to any one of claims 8 to 14 or a receiver according to any one of claims 15 to 21 wherein means are provided to limit the rate of change with respect to time of control information.

23. A remote control system constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

24. A transmitter for use in a remote control system, the transmitter being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 5 of the accompanying drawings.

25. A receiver for use in a remote control system the receiver being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 3 and 6 and 7 of the accompanying drawings.

26. The invention herein defined in all its new and useful aspects.

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